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Higher Education and Science Policies in the Arab Region: National, Regional and Global Processes

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Abstract

In this paper we discuss the interaction between science policies (and particularly in the area of scientific research) and higher education policies in Gulf and Mediterranean Arab countries. Our analysis reveals a discrepancy between the two sub-regions with respect to integration in the global market, cooperation in scientific research and international mobility of students. The paper discusses the implications of the analysis of reform policies and higher education restructuring.

Keywords: Higher Education, Science Policies, Arab Region, Regional Influence, Global Influence.

JEL classification: I20, I23, I28, O10, O15, O30

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INTRODUCTION

Economists from different schools of thought consider education as a crucial human capital in the initiation, acceleration, and sustainability of economic growth and improvement of the quality of life in society. New growth theories and the empirical literature recognize the importance of human capital accumulation/formulation for economic growth.[2] There is increasing debate in the literature regarding the relevance of the new growth theories to the developing countries. Apart from this increasing debate and practical limitations for the relevance of the new growth theories for the developing countries, in the recent years there is a growing body of literature on the role of public policies and government intervention to promote human capital and technological capabilities in the developing countries. For instance, Lall (1999) discusses strategies to develop skills and capabilities in developing countries and argues that there is a valid case for policies to coordinate, guide and subsidize learning; and to develop such factors as skills and technology where externalities and information failures are particularly pervasive. He identifies two broad successful strategies in the developing world to promote skills and learning for competitiveness. First, autonomous strategies to accelerate and guide learning by domestic firms by promoting infant industries, coordinating investments in related activities, overcoming externalities, directing credit, and developing specific skills and institutions. Second, foreign direct investment (FDI) dependent strategies that rely on Transnational Corporations (TNCs) to lead export growth and upgrading, which has two subsets of strategies: those based on targeting TNCs and using industrial policy to guide them in more technology intensive activities; and more passive strategies that rely on market forces to attract and upgrade activities. Korea and Taiwan are leading example of national-led strategy, Singapore and Malaysia of the FDI-led targeted strategy, and Mexico and Thailand of the FDI-led market-led strategy (Lall, 1999: 9-10). In addition, Lall (1998) provides a useful analysis of the relationship between technology and human capital in maturing Asian countries and explains the close link between economic and industrialization policies on the one hand and S&T policies and developments on the other. Lall (1998) also analyzes the human

[2] See, for example, Robert Lucas, 'On the Mechanics of Economic Development', Journal of Monetary Economics, 22, (1988), 3–42; and Paul Romer, 'Endogenous Technological Change,' Journal of Political Economy, 98(5), (1990), S71–S102.

capital (mainly, tertiary enrolment especially in technical subjects) strategies followed by these countries and explained their link to the impressive performance of the technological leaders of different Asian economies. Lall (1998) concludes his analysis with the following: "It is clear that the Tigers [Singapore and Korea] have advanced the furthest in creating a broad educational base that is required by human capital development. The Korean effort overall is impressive, but it is particularly remarkable in terms of the output of university trained technical personnel: it is this which provides the 'brain-power' for the immense industrial machinery. … The new Tigers [Indonesia, Malaysia and Thailand] have, in comparison, shown relatively weak performances in education and training… Enlarging, broadening and improving the educational base thus have to be a top policy priority for these countries… The large inward-oriented countries [China, India and Pakistan] have the weakest human capital base for sustained industrial upgrading. (Lall, 1998: 31 – 32).[3] Moreover, Amsden (2001) discusses and compares the industrialization experiences of several developing countries spanning Latin America (Argentina, Brazil, Chile, and Mexico), the Middle East (Turkey) and Asia (India, China, South Korea, Taiwan, Malaysia, Indonesia, and Thailand). She indicates that after World War II a select number of countries outside the North Atlantic, Japan and the West--those that Amsden calls "the rest"--gained market share in modern and a wide range of mid-technology industries and altered global competition. The rise of 'the rest' was historically unprecedented, as although in 1965 the rest had supplied less than a twentieth of world manufacturing output, by 1995 it supplied nearly one-fifth. The late industrialization that adopted the independent approach like China, India, Korea and Taiwan, which in 1990s were previously notable for their nationally controlled firms and surging investments in technological capabilities, by 2000 they had acquired sufficient manufacturing experience and had built their own national manufacturing enterprises that were investing heavily in R&D. By contrast, the late industrialization that adopted the integrationist approach like Argentina, Brazil and Mexico, which in 1990s were previously characterized by heavy reliance on foreign direct investment and minimal local expenditures on skills (as measured by research and development), by 2000 they

[3] See Sanjaya Lall, 'Technology and human capital in maturing Asian countries,' Science, Technology & Society, 3(1), (1998), 11-48; see also Sanjaya Lall, 'Competing with Labour: Skills and Competitiveness in Developing Countries', Issues in Development Discussion Paper 31, (Geneva: International Labour Organization, 1999), 9-10.

had experienced a wave of acquisitions and mergers that left even more of their leading enterprises controlled by multinational firms. The rise of the rest involved intense learning and knowledge as a crucial determinant of economic growth; acquisition of knowledge-based assets; innovative control mechanisms imposing discipline on economic behaviour; globalization and institution building. It also implies an extensive role for the government and the importance of state as a facilitator and guide of economic development and the formation of specific types of business enterprise; that had transformed these countries into champions of science and technology.[4]

In recent years, the debate on the importance and interaction between higher education, S&T, knowledge, the socio-economic, political and institutional contexts has gained ground in the Arab region as well. The United Nations Development Programme (UNDP)-sponsored Arab Human Development Report (AHDR) highlighted the centrality of human capital (higher education) and knowledge (science and technology) for the development of the Arab region.[5] Earlier analyses have illustrated the importance of education, and investigated the causes and consequences of inadequate educational and training systems. They have also examined the reasons for weak science and technology (S&T) indicators in the Gulf countries.[6] Moreover, the UNDP Arab Reports, and more recently Arab Knowledge Report, the ESTIME and UNESCO projects indicate a low status of knowledge in the society that attributed to the lack of socio-economic and political and institutional context unfavorauble environment, a lack of trust in science (rather than in religion), the type of economy and the strategy of development (built on finance or on mature heavy industry rather than on industries needing technological

[4] See Alice H. Amsden, 'Industrializing Late' Chapter One in 'The Rise of "the Rest": Challenges to the West from Late-Industrializing Economies', Oxford, United Kingdom, New York, Oxford University Press, (2001), 1-28.

[5] See United Nations Development Programme (UNDP)-Arab Human Development Report (AHDR) 2002: Creating Opportunities for Future Generations (New York and Amman: UNDP-Regional Bureau for Arab States (RBAS), 2002); and UNDP-AHDR, Arab Human Development Report 2003: Building a Knowledge Society (New York: UNDP-RBAS and Jordan-Amman: National Press, 2003), United Nations Development Programme (UNDP)-Arab Human Development Report (AHDR) 2004: Towards Freedom in the Arab World (New York and Amman: UNDP-Regional Bureau for Arab States (RBAS), 2004) and United Nations Development Programme (UNDP)-Arab Human Development Report (AHDR) 2005: Towards the Rise of Women in the Arab World (New York and Amman: UNDP-Regional Bureau for Arab States (RBAS), 2005).

[6] See, for example, Hamed Al-Sulayti, 'Altalim wa Altanmia Albasharia fi Dwal Maglis Altawan Lidowal Alkhalej Alarabia: Dirasa Tahlilia' ('Education and Human Development in the GCC Countries: An Analytical Study'), Strategic Studies, 71, (2002), 1-54; J. Muysken and S. Nour, 'Deficiencies in Education and Poor Prospects for Economic Growth in the Gulf Countries: The Case of the UAE', The Journal of Development Studies, 42 (3), (2006), 957–980. See also Samia Nour, 'Science and Technology (S&T) Development Indicators in the Arab Region: A Comparative Study of Arab Gulf and Mediterranean Countries', UNU-INTECH Discussion Paper Series, No. 2005-3, (2005a); Samia Nour, 'Science and Technology (S&T) Development Indicators in the Arab Region: A Comparative Study of Arab Gulf and Mediterranean Countries', The Journal of Science, Technology and Society, 10(2), (2005b), 249–274; and Samia Nour, Technological Change and Skill Development in the Arab Gulf Countries (Maastricht: Maastricht University Press, 2005c) (doctoral dissertation).

innovation) which are all important factors that up to the last decade hampered the development of research in most parts of the Arab region.[7] For instance, UNDP-AHDR (2003) indicate that the low spending on R&D, the relatively small number of qualified knowledge workers and number of scientists and engineers working in R&D and number of students enrolling in scientific disciplines in higher education, poor institutional support and a political and social context inimical to the development and promotion of science in the Arab states. In addition, in the Arab countries' experiments with the transfer and adoption of technology have neither achieved the desired technological advancement nor yielded attractive returns on investments. Importing technology has not led to its adoption and internalisation in the host country, let alone to its diffusion and production. The two biggest gaps accounting for this failure have been the absence of effective innovation and knowledge production systems in Arab countries, and the lack of rational policies that ingrain those essential values and institutional frameworks that support a knowledge society. These problems have been aggravated by the mistaken belief that a knowledge society can be built through the importation of scientific products without investing in the local production of knowledge, and through depending on cooperation with universities and research centres in advanced countries for training Arab scientific cadres without creating the local scientific traditions conducive to knowledge acquisition in the region. The lack of national innovation systems in Arab countries represented, in effect, a waste of investment in industrial infrastructure and fixed capital (buildings, factories, machinery and equipment). Such investments did not bring the wealth that Arab societies had sought through means other than the depletion of raw materials, nor expected social returns. Moreover, the Arab countries have not succeeded in becoming important poles of attraction for foreign direct investment (FDI). None of them figures among the top ten FDI attracting countries in the developing world, probably due to lack of an organisational context that provides incentives for knowledge

[7] See Arab Knowledge Report, 'Towards Productive Intercommunication for Knowledge,' Report produced through joint sponsorship and support of the Mohammed bin Rashid Al Maktoum Foundation (MBRF) and the United Nations Development Programme/ Regional Bureau for Arab States (UNDP/RBAS), Al Ghurair Printing & Publishing House L.L.C, Dubai, United Arab Emirates, 2009. See also ESTIME 'Towards science and technology evaluation in the Mediterranean Countries' Sixth framework programme Project: Evaluation of Scientific, Technology and Innovation capabilities in Mediterranean countries (2006), 1-80, www.estime.ird.fr . See also UNESCO, 'Mapping Research Systems in Developing Countries: Regional Report on Arab Countries,' UNESCO Forum on Higher Education, Research and Knowledge; UNESCO, France, (2006), 1-55. See also UNESCO, 'Mapping Research Systems in Developing Countries: Synthesis Regional' UNESCO Forum on Higher Education, Research and Knowledge; UNESCO, France, (2006), 36-59

production and consolidates linkages between R&D institutions and the production and service sectors and promote national capabilities for innovation. Another problem is the lack of the societal context for knowledge acquisition in the Arab countries; the knowledge system is influenced by societal, cultural, economic and political determinants. The most part of the Arab region suffers from the insufficient legislation; institutionalism and enabling environment for promotion of scientific research in the Arab. This implies that prioritizing of institutionalism is a way of accessing the knowledge society in Arab countries. Furthermore, AHDR (2003) indicates that it is not possible for Arab countries to benefit from the fruits of global knowledge production and technology without investing in local production, local knowledge workers and local knowledge traditions. Current indicators of research production and economic output tell this story plainly enough. The report concentrates on impediments to knowledge in the Arab world. This analysis includes culture (heritage, religion and language); the dominant socio-economic structure (modes of economic production, growth and income distribution and class structure, attitudes and values) and politics (political systems, the role of elites, the corruption of knowledge by politics); and the regional and global environment for knowledge transfers and development. According to the report the production of knowledge is driven by strong and increasing societal demand and the political will to secure the resources necessary for stimulating a vital and capable knowledge system. This includes building high caliber human capital as a base, and ensuring an environment of policies and institutional structures conducive to the system's effective functioning. Important as they are, these factors are in turn affected by societal, cultural, economic and political determinants which also have a bearing on the knowledge system – for knowledge does not evolve in a social vacuum but rather in a particular society that has a reality, a history and a regional and global context.[8] According to Arab Knowledge Report (2009), knowledge acquisition, production, indigenization and deployment becomes a tool and goal that affects all levels of society equally and involves all of fields, from the scientific, technical, cultural, and traditional to accumulated community wisdom. The successful deployment of the knowledge produced in all spheres of economic and social activity contributes effectively to the expansion of

[8] See UNDP-AHDR "Arab Human Development Report" (2003) op. cit. note 4, 4-13, 109-113.

human choice and emancipation. The report presents a general theoretical framework for the knowledge society, based on four major axes to close knowledge gaps in the Arab world and achieve comprehensive human development.[9,10]

This paper aims to improve understanding about a little-known topic, one of its advantages is that it deals with the Maghreb, Machreq and with the Gulf countries together, whereas most other studies have interest and focus in only one of these zones and do little comparison. Additional advantages of the paper are that it gives a review of the debates (principally within international organisations) on the status of sciences in the Arab countries, with references, it gives a synthesis about the state of the institutions (principally regarding higher education) as to their quantity and some problems of quality. In addition it also explains the division between two groups of countries (paying special attention to the Gulf countries) and their comparison; it gives a discussion choosing relevant indicators, it makes the distinction between several levels of effects (national, regional, global) and their consequences (including the flow of students and the cooperation in R&D) and the discussion of their roots (especially the linguistic issue).

Based on the above, the present paper aims to address concerns in the area of science policies in the Arab states and their relation to higher education. First, we discuss the intersection between higher education policies and science policies in the Gulf and Mediterranean Arab countries.[11] We compare these two sub-regions to rapidly advancing emerging Asian countries in terms of S&T and skills indicators and international mobility of students. Second, we compare regional and global processes insofar as they influence the intersection between higher education and science policies in each of the two Arab sub-regions. Third, we show the weak regional cooperation in the areas of scientific

[9] See Arab Knowledge Report (2009), op. cit. note 6, 28

[10] According to AHDR (2003) knowledge is a multi-dimensional concept, knowledge consists of data, information, instructions, and ideas, or the sum total of symbolic structures possessed by individual human beings or by society at large. These symbolic structures guide individual and institutional human behaviour in all walks of life and in all spheres of public and private activity. Knowledge includes, for instance, the symbolic structures which are acquired through formal education and experiences learned from work and life. The institutional knowledge of a society includes history, culture, strategic orientations and organizational forms. Consequently, knowledge can be explicit (recorded in one form or another) or implicit (in the form of spontaneous behavioural prescriptions, for example). According to Arab Knowledge Report (2009), Knowledge is a human right and a means to overcome many of the difficulties and obstacles facing mankind. The Arab Knowledge Report (2009) uses the term "knowledge" to embrace all forms of a society's epistemological and cultural assets and views it as a major organizing principal of holistic human development. Knowledge in this sense seeks to expand options and opportunities available to the individual Arab and to achieve for him or her freedom and an honourable life. See UNDP-AHDR (2003) op. cit. note 4, 36; see also Arab Knowledge Report (2009), op. cit. note 6, 28

[11] The Arab Mediterranean includes eight Arab countries: Algeria, Egypt, Lebanon, Libya, Morocco, Palestine, Syria, and Tunisia. The Arab Gulf includes six Arab countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE). The other non-Gulf-non-Mediterranean Arab countries are: Djibouti, Iraq, Jordan, Mauritania, Sudan, and Yemen. The Maghreb sub region includes: Algeria, Morocco and Tunisia, the Machreq sub region includes: Lebanon, Jordan and Syria.

collaboration and higher education among Arab countries. In this, we expand ESTIME and Zahlan's analyses, who studied scientific cooperation and productivity in the Arab region. We discuss the influence of international institutions in higher education using several indicators: the contribution of foreign universities in the Gulf and Mediterranean Arab countries, the contribution of the foreign students and staff members in the Gulf Arab universities, and the inflow and outflow of students from Gulf and Mediterranean Arab countries to Europe (the UK, France, and Germany), the USA, and Australia.[12]

In this paper we argue that the Arab countries must restructure higher education and science policies, socio-economic, political and institutional contexts if they are to meaningfully address the challenges imposed by a competitive global economy. Second, we argue that a reform of higher education, socio-economic, political and institutional contexts will have positive implications for science policies and will strengthen the linkages between scientific R&D and higher education. Third, we argue that regional and global organizations have the potential to contribute positively to the restructuring of higher education and science policies (and scientific research) in the Arab region. Fourth, we argue that effective institutional environments and consistent national and regional policies will enhance higher education and science policies in the Arab countries.

We begin by presenting the general socio-economic characteristics of the two groups of Arab countries: in the Mediterranean region and the Gulf. We then comparatively discuss the status of higher education in each of these sub-regions and compare them to emerging Asian countries. This is followed by a discussion of global influences on higher education and science policies in the Arab countries. We conclude by clarifying the major insights gained from this analysis.

THE ARAB REGION

Table 1 presents the major socio-economic characteristics of the Mediterranean and Gulf Arab countries. With the exception of Saudi Arabia, the Gulf Arab countries generally

[12] Antoine Zahlan, 'Science Policy for the Twenty-First Century: Mobilization and Development', in Economic and Social Commission for Western Asia (ESCWA) ESCWA Proceedings of the Expert Group Meeting on Science and Technology Policies and Strategies for the Twenty-First Century (Beirut, 10–12 March 1999) (New York: United Nations, 2000), 14–16; and Antoine Zahlan, The Arabs and the Challenges of Science and Technology: Progress without Change (Beirut: The Center for the Study of Arab Unity, 1999).

have smaller populations than Mediterranean Arab countries. The Mediterranean countries are also generally larger geographically than the Gulf countries. There is considerable diversity between the two sub-regions in terms of demographic composition and standards of economic development as indicated by GDP per capita and the Human Development Index (HDI).

Insert Table 1 about here

The Gulf Arab countries exhibit higher standards of economic development and growth indicators (as measured by GDP per capita) compared to their Mediterranean counterparts. According to World Bank classifications, all of the Gulf Arab countries rank as high income countries. Among the Mediterranean Arab countries, however, all but Lebanon and Algeria are in the lower medium income group. Moreover, the UNDP human development indicators show that the average GDP per capita in all the Gulf countries is higher than both the world average and the average for Arab countries generally. The average GDP per capita in all the Mediterranean countries ranks among world medium income countries, and on average is lower than the average for Gulf countries and that of all Arab countries.

These differences are also true of the HDI and the indicators of average literacy rates and combined enrolment ratios. Among Mediterranean Arab countries, Lebanon, Tunisia and Algeria show relatively good performance with respect to both economic and human development indicators. Moreover, the combined enrolment ratio is higher in Lebanon, Egypt, and Tunisia. Among the Gulf Arab countries, Qatar, the United Arab Emirates (UAE), Kuwait and Bahrain show relatively good performance economically and in terms of human development indicators compared to Saudi Arabia and Oman. Finally, poverty is much more prevalent in the Mediterranean Arab countries – especially in Egypt and Algeria – than in their Gulf counterparts. These differences [in the standards of economic development and growth indicators (as measured by GDP per capita) and human development indicators] reflect, among other things, the impact of the distinct politico-economic and social structures prevalent in the two sub-regions and the higher reliance of Gulf Arab countries on oil rents and international oil markets.

HIGHER EDUCATION AND SCIENCE POLICIES: NATIONAL HUMAN AND FINANCIAL (RESOURCES) INPUT INDICATORS

Available data show a considerable disparity between the Gulf and Mediterranean Arab countries, and between these and other countries, in terms of both financial and human resources devoted to S&T development. Generally, financial and human S&T input indicators in Arab countries lag behind those of the rapidly advancing emerging countries in Asia.[13] In particular, the percentage of spending on research and development (R&D) relative to GDP is low in the Arab countries compared to emerging Asian countries like Singapore, Korea, India, and China. For instance, according to UNDP-AHDR (2003) in the Arab state spending on R&D, does not exceed 0.2 percent of GNP (most of which pays only for salaries). Moreover, according to ESTIME (2006) in the Mediterranean Arab countries in the late nineties the efforts for financing research has been very low, ranging from 0.20% to 0.40% of GDP. The figures have grown in 2005 from a low 0.20% (Algeria, Lebanon) to a high 1% (Tunisia). Tunisia is the only country that claims having accessed the 1% of GDP and has declared it wants to attain an objective of 1.25% of GDP for 2009. Morocco is probably heading towards the 1%.[14] On average, the all Arab countries devote only about 0.3% and 0.1% of their GDP to R&D, respectively, compared to emerging Asian countries. The latter invested 1.1% to 3% of their GDP in R&D during the period from 1996 to 2002. Arab countries [except Tunisia] thus do not meet the 1979 United Nations (UN) recommendation of spending 1% of GDP on R&D. To do so, they would need to increase spending to at least 0.5% of GDP, and to 1% within five years, if they plan to enhance S&T for development. Moreover, emerging Asian economies invested heavily in higher education and R&D for a decade before securing returns from knowledge or creating wealth from knowledge.[15]

[13] See UNDP, Human Development Report, 2002: Deepening Democracy in a Fragmental World (New York: UNDP and Oxford: Oxford University Press, 2002); UNDP, Human Development Report, 2003: Millennium Development Goals: A Compact Among Nations to End Human Poverty (New York: UNDP and Oxford: Oxford University Press, 2003); UNDP, Human Development Report, 2004: Cultural Liberty in Today's Diverse World (New York: UNDP and Oxford: Oxford University Press, 2004); Lall, (1999), op. cit. note 2, 17.

[14] See ESTIME (2006), op. cit. note 6, 25.

[15] The returns were in the form of software in India; hardware in China; electronics and automobiles in Korea; electronics in Taiwan; semiconductors and Communications and Information Technology [C&IT] in Malaysia. Nour (2005b), op. cit. note 5, 255–260.

COMPARING ARAB AND EMERGING ASIAN COUNTRIES

We are aware of the fact that comparing Arab with the emerging Asia countries is probably somewhat problematic from analytical perspective; particularly because the massive growth of the investment in education to promote higher education, research and S&T of the Gulf countries can be explained in relation to the rising revenues from oil. But we believe that the experiences of the emerging Asian countries provide useful lessons for the Arab countries to promote education and S&T policies. For instance, the findings of Amsden and Lall as we explained in Section 1 above, indicate that the experiences of emerging Asian countries involved intense learning and acquisition of knowledge as a crucial determinant of economic growth; innovative control mechanisms imposing discipline on economic behaviour; globalization and institution building. It also implies an extensive role for the government to guide economic development, promote a broad educational base and human capital (mainly, by development of tertiary enrolment especially in technical subjects and trained technical personnel); science and technology policies and technological capabilities as a top policy priorities for these countries.

When comparing S&T indicators between the two Arab sub-regions, data indicate that the Mediterranean Arab countries have a higher average expenditure on education and R&D as a percentage of GDP than their Gulf counterparts. While financial resources (as measured by the share of expenditures on R&D) in Tunisia, Egypt and Saudi Arabia are higher than in other Mediterranean and Gulf countries, in general their performance still falls behind that of emerging Asian countries. At the same time, financial resources devoted to education, as measured by public spending on education as a percentage of GDP, are higher in most of the Mediterranean and Gulf Arab countries than in Korea and Singapore. However, public spending on education as a percentage of total government expenditures in both the Mediterranean and Gulf Arab countries falls behind Korea and Singapore. These findings suggest that restructuring education in the Arab countries is closely tied to public policy roles and would require a firm commitment on the part of governments to increase the priority and proportion of spending on education.

On the issue of human resources in S&T, UNDP-AHDR (2003) indicates that in the Arab region the number of qualified knowledge workers is relatively small. The

number of scientists and engineers working in R&D in Arab countries is not more than 371 per million citizens. This is much lower than the global rate of 979 per million. The number of students enrolling in scientific disciplines in higher education in all Arab countries is also generally low, in comparison to countries that have used knowledge to take off, such as Korea, although among Arab countries, Jordan, followed by Algeria have distinguished themselves in this field. Data further shows that the number of scientists and engineers in R&D is low in the Gulf and Mediterranean Arab countries compared to emerging Asian countries such as Singapore and Korea. The inadequate human resources in the Gulf and Mediterranean Arab countries fall behind not only emerging Asian countries, but also not surprisingly still fall behind the advanced European countries. For instance, the Second European Report on S&T Indicators of the Organisation for Economic Co-operation and Development (OECD) shows that the level of R&D personnel in the Mediterranean countries is proportionately ten times lower than in the European Union.[16] Given that the Gulf countries lag behind the Mediterranean countries, the proportions in the Gulf countries are likely even lower. In addition, human resources in S&T, as measured by skill indicators, are low in both the Gulf and Mediterranean Arab countries compared to the emerging Asian countries. The only exception is the share of tertiary students in science, math, and engineering in Algeria, which is higher compared to both other Arab countries and emerging Asian countries. El Kenz and Waast provide an interesting interpretation of Algeria's an overspecialization in science, math and engineering due to considerable, special and remarkable attention granted to S&T that date back to earlier awareness and enthusiasm by the nationalist leaders and student associations, and also the social structure here is more important than ever to explain this pecuality. The essential goal of Algerian earlier focus on S&T was that they should gain an education and acquire competence in S&T which they would use to take over a European techno-structure, otherwise destined to vanish after independent. They attribute Algeria earlier focus on S&T to satisfy the needs of the time after independence of Algeria from French colonization in July 1962, notably, the earlier conscious of Algerians nationalist leaders about the lack of the scientific and technical facilities, the qualified skills, and the fact that the [French] colonial system had trained

[16] OECD, Second European Report on S&T Indicators (Paris: OECD, 1997).

such few Algerian technicians and scientists meant that there was now a gap to be quickly bridged so as to minimize the hardships of managing the economic and administrative machinery and technological infrastructure in the post independence period. It nevertheless remains a sign of the eclecticism of Algerian nationalism in this domain, contributing to the founding of an essentially 'positivist' approach to S&T. The university scientific community was the worst hit, while it had been organizing and conducting its research work according to the S&T 'options' solemnly adopted by all the various successive post-independence political regimes, the education system had been on another path.[17]

COMPARING MEDITERRANEAN AND GULF ARAB COUNTRIES

When comparing the two Arab sub-regions, on average the Mediterranean countries have more employees, scientists, and engineers in R&D areas per million inhabitants than their Gulf counterparts. In particular, average skill indicators are higher in the Mediterranean countries compared to their Gulf counterparts. At the same time, however, we observe significant differences within and between the Mediterranean and Gulf regions, probably the result of demographic variations. Large populations result in more R&D employees in the Mediterranean area compared to the Gulf area. For instance, the combined population of Algeria and Morocco is roughly equal to the total population of all the Gulf countries; even more dramatically, the population of Egypt is more than twice the total population of all the Gulf countries.

With regard to human resources devoted to R&D, data presented by Waast and Krishna suggests that Egypt leads the Mediterranean Arab countries in terms of total number of researchers per million inhabitants, academic staff in the public sector, and researchers in the government, industry, business, and non-profit sectors.[18] This is a result of Egypt's large population, which is more than seven times that of Tunisia, four times that of Syria, and twice that of Morocco and Algeria. Yet, it is also the result of dramatic expansion of the higher education sector, and particularly universities, following the

[17] See Ali El Kenz and Roland Waast 'Sisyphus or the Scientific Communities of Algeria,' in Jacques Gaillard, V.V. Krishna and Roland Waast Scientific communities in the developing world. London & New Delhi, Sage, (1997), 56-57, 67.
[18] See Roland Waast and Venni Krishna, 'The Status of Science in Africa', The Journal of Science, Technology and Society (Special Issue): The Status of Science in Africa, 8(2), (2003), 148-152.

overthrow of the monarchy in 1952. In addition Egypt leads the Mediterranean Arab countries in terms of total number of scientific publications. For instance, according to UNESCO (2006) the growth in the number of articles published in high-quality international journals was not the same in different sub zones. Egypt progressed slowly during the 1980s and even stagnated during the 1990s. Since 2000 it has regained momentum and this is linked to a new leap forward of the number of students (and staff in the universities). Machreq went at a quicker path; but this is especially true in Jordan (which almost doubled its participation in the world science during the last decade) and in Lebanon (after the civil war and thanks to numerous foreign cooperation). However the most remarkable feature is the spectacular growth in Maghreb production. Within the last fifteen years Morocco more than doubled its participation in articles published by the best international journals (nearly 1 000 participations each year), Algeria did the same in spite of a six years civil war. Tunisia shows the most constant and powerful growth, it almost tripled the number of its publications in the last decade, and the growth is accelerating since the new structuring of research and its nurturing by the state (1998). On the opposite side, the Gulf countries are stagnating (as well as Saudi Arabia) except for the countries (Emirates and Qatar) which imported foreign campuses: thanks to these contributors their scores increased tremendously but they remain modest (200 to 400 participations per year).[19] Moreover, according to ESTIME (2006) figures based on Science Citation Index (SCI) (2006) database indicate that SCI Scores in Egypt, Tunisia; Morocco and Algeria are 2743; 1079; 756 and 728 respectively, while the percentage shares in world publication production (%) in 2004 are 3.42; 1.08; 1.26 and 0.73 respectively. According to ESTIME (2006) after South Africa, Egypt and Tunisia then Morocco closely followed by Algeria, have a good record of publications. Apart from Syria, smaller players like Lebanon and Jordan have also an honourable record of publications. In contrast to UNESCO (2006), ESTIME (2006) indicates that the Gulf countries or Saudi Arabia are also close in terms of quantities of production. According to ESTIME (2006) over the period (2001-2006) the growth in the shares of world publication production for Morocco; Algeria; Tunisia; Egypt; Jordan; Lebanon and Syria is estimated at 0.98; 2.0; 2.05; 1.23; 1.60; 1.35; 1.33 respectively; the growth in the

[19] See UNESCO, (2006), op. cit. note 6, 49. See also UNESCO, (2006), op. cit. note 6, 36-59

shares of world publication production over the period (1999-2004) is estimated 4; 48; 63; 14; 17; 49 and 1 respectively and the growth in the shares of world of publication production over the period (1993-2004) is estimated 100; 89; 125; 5; 94; 250 and 18 respectively. These figures imply the dramatic, impressive and extremely strong growth in the last twenty years in the Maghreb countries (especially, in Morocco and Tunisia).[20]

HIGHER EDUCATION QUALITY, R&D AND HUMAN CAPITAL FORMATION

In all Arab countries, not only is there a lack of financial and human resources for S&T development, but there are also serious challenges to the development of higher education. This is particularly true in the areas of mathematics and science which are critical for technological skill development.[21] The low percentage of students in science, mathematics, and engineering in the Gulf and Mediterranean Arab countries, with the exception of Algeria, is particularly challenging.[22] UNESCO estimates for the year 1996 indicate that Gulf enrolment ratios in medical sciences, natural sciences, engineering, and agriculture accounted for 28% of all tertiary students; the remaining numbers were enrolled in arts, humanities, law, and social sciences. For Mediterranean Arab countries, on average enrolment and graduation ratios in medical sciences, natural sciences, engineering, and agriculture accounted for 35% and 39% compared to 63% and 60% for art, the humanities, law, and social sciences, respectively. This imbalance is particularly significant in Saudi Arabia, Qatar, Oman, and the UAE.[23] Moreover, Nour found that medical sciences, natural sciences, science, engineering, and agriculture faculties account for more than half of the total faculties in the universities of Cairo and King Saud. However, irrespective of the year of establishment, the share of students enrolled in these faculties represents only around one-third of total enrolled students over the period 1993/1994–2002/2003.[24] Although low enrolment in science fields in Arab region is somewhat problematic, but enrollments in science faculties are rather low also in European countries.

[20] See ESTIME (2006), op. cit. note 6, 29-31, www.estime.ird.fr
[21] Lall, op. cit. note 2, 17, 22–23.
[22] UNDP (2003, 2004), op. cit. note 4; see also Nour (2005a, 2005b) op. cit. note 5.
[23] See UNESCO-UIS, 'World Education Report (2000): UNESCO's World Education Indicators – Table 9', http://www.unesco.org/education/information/wer/WEBtables/Ind9web.xls, accessed 20 October 2006.
[24] Nour (2005b), op. cit. note 5, 263.

Nour indicates that one major problem of the educational system in the Gulf countries is the recent stagnation in enrolment in tertiary education. For example, after considerable improvements in enrolment in tertiary education in the UAE until around 1994, enrolment figures have decreased in recent years.[25] Further, according to the Word Development Indicators Database, the percentage of gross enrolment in tertiary education increased from 5% in 1980, 12.8% in 1985, and 20.3% in 1994, to 21.1% in 1995. In subsequent years, however, it declined to 20.3% in 1996 and 1997, 20.7% in 1998, and 19% in 2000. There was a temporary increase to 24% in 2001, followed closely by a decline to 23% in 2002 and 22% in 2003.[26] Women represent the majority of total enrolments in higher education in the Gulf countries; the majority of women, however, enrol in the humanities and social sciences. In the Gulf countries, while the rising revenues from oil contribute to a growth of the educational system in Saudi Arabia and the Emirates, but Bahrain is a sort of counter-evidence of the close relation between oil and knowledge. Bahrain has in fact been quickly looking to get out of the oil trap, and they chose knowledge early, Bahrain has made a remarkable achievement in education by putting special emphasis on technical secondary education which implies greater emphasis on the acquisition of the practical skills needed for the performance of a specialised vocation as well as the formation of technicians capable of adjusting to changing job requirements. Available statistics indicate that during the last three decades of the twentieth century, the educational systems in the Arab region were able to create a critical mass of technicians capable of meeting the demands of the labor market in only Egypt, Tunisia, Bahrain, and Lebanon. In the Gulf countries only in Bahrain enrolment in technical secondary education has reached acceptable level to equip young technicians with the knowledge and know-how to meet the demands of the knowledge economy. Other Gulf countries rely on under-qualified local labor or imported expertise, whether from other Arab countries or abroad. The expansion in general and technical secondary education and its impact on female enrolment lead to positive impacts in Bahrain. For instance, compared to other Gulf countries, Bahrain has scored a series of achievements in education that have raised it to level of the vanguard of Arab countries in this domain. Bahrain boasts one of the lowest ratios of children out of school, the highest level of net

[25] Nour (2005c), op. cit. note 5, 125.
[26] See the Word Development Indicators Database, 2005-2006.

enrolment in primary education, the best enrolment rates in secondary education as a whole, and gender parity. It has nearly reached the saturation point in enrolment rates at the upper secondary education level, and it has the highest enrolment rate in technical secondary education among both Arab and Asian countries. Secondary education enrolment rates in Bahrain have risen steadily from 1999 to 2006. This growth is due to the noticeable increase in the enrolment of young women and men in the technical and vocational programmes. This increase is much higher than the rise in the gross enrolment rate at this educational level, whether taking into account all programmes combined or only the general secondary school programmes. This quantitative development is undoubtedly connected with the structural reform of secondary education that Bahrain put into effect in the last decade. In addition to diversifying the programmes of technical secondary education and providing an element of flexibility in these programmes, the avenue is now open to enrol in corresponding higher educational programmes, thereby offering a horizon for technical secondary school graduates to continue their studies and progress further in their vocational choice. Some characteristics of Bahraini society may have played a part in this dual development (the rise in technical secondary school enrolment and the rise in female enrolment in this educational branch). Bahrain is an urban society. With a per capita income lower than that of other small Gulf countries, it depends more on its own people than on imported labor to keep life's wheels turning and promote economic development.[27]

Apart from the problem with regard to enrolment ratios, as with most developing countries, the quality of education in the Arab region poses a serious problem. On the issue of the quality of higher education, the AHDR indicates that three-quarters of Arab universities were established in the last quarter of the 20th century, and 57% are no more than 15 years old.[28] This observation is telling since higher education institutions, and universities in particular, require a long time to consolidate their institutional structure, and to foster their role in the dissemination and production of knowledge.[29] The AHDR authors observe that the quality of higher education institutions in Arab countries is [sometimes] affected by many factors, chief among which is the [often] lack of a clear

[27] See Arab Knowledge Report (2009), op. cit. note 6, 111-113.
[28] Op. cit. note 4.
[29] Nader Fergany, Ro'iah Mustaqbaliyah lil Ta'leem fi-l-Wattan Al-'Arabi: Al-Watheeqa Ar-Rai'eesiyah (A Future Vision for Education in the Arab World: The Main Document) (Cairo: Almishkat, 1998), 18–19.

vision, and, as noted earlier, [sometimes] the absence of well-designed policies regulating the educational process. … One of the main features of many universities in the Arab world is their [often] lack of autonomy, i.e., they [often] fall under the direct control of the ruling regime. This lack of autonomy [sometimes] has resulted in a situation where universities run according to the requirements of the governing political rationality and not according to a plan. [30] Furthermore, in most Arab countries, the structure and pattern of higher education is characterized by a centralized bureaucracy which, as remarked by Al-Sulayti 'implies a high degree of centralization and intervention from the governments/ministries of education to control all the educational institutions'.[31] Sometimes, the ministries of education administer around 95% of educational affairs, and sometimes, higher education institutions lack independence and initiatives in the area of R&D. They are often subordinate to state bureaucracy, routine, and institutional rigidity. They also sometimes, lack a proper articulation of 'educational policies, dynamism, flexibility, planning, organizational development, monitoring, assessment, cooperation and problem solving ability'.[32] One shared feature of the education policies in the Mediterranean and Gulf Arab countries is that public education is perceived as being very important for development. However, as indicated by Al-Sulayti, both uncertain public revenues (oil revenues in particular) and increasing competition for these revenues for defence and infrastructure spending make it difficult for Gulf countries to continue allocating high proportions of public revenues on education.[33] Private spending on education has increased slightly in recent years to fill the funding gap in most of the Gulf countries; however, educational investment is still almost entirely public. Until 2001, tertiary education was publicly provided: there are only one or two universities in each of Bahrain, Kuwait, Oman, and Qatar; in each of Saudi Arabia and the UAE there are eight universities, some with internationally accredited private institutions.[34] It is probably true that the Gulf war and the post-Gulf war economic effects increased the public spending on defence and put further pressure on public spending on higher education. Another effect was that the Gulf region became more allied with US interests in the region,

[30] UNDP-AHDR, op. cit. note 4, 56.
[31] Op. cit. note 5, 29–30.
[32] Mohamed Fahmey and Hassan Mahmoud, 'Moushkilat Alidara Altalimia fi Dowel Almaglis' ('Problems of Educational Administration in the Gulf Cooperation Council Countries'); Al-Sulayti, op. cit. note 5, 29–30.
[33] Op. cit. note 5.
[34] Ibid. See also Muysken and Nour, op. cit. note 5, 970–971.

facilitating the introduction of American private higher education institutions. Furthermore, although in the recent years all Arab countries are overwhelmingly open to private education, but it has not produced yet any visible result, it might, sometime in the future, but today, it has not yet. Moreover, in the Arab region, there are several good public universities, for example, in Jordan both Jordan University and Jordon University of Science and Technology are both good examples of public universities. In addition in most Arab countries, private universities are mainly businesses; the only exceptional cases the situation of older "private" universities such as St Joseph or AUB in Beirut which are probably a little different, as they rely on a history of good teaching and patient growth of research. The increasing private sector's contribution and the observed shortcomings in the performance of the government or public institutions and interventions, however should not hide the fact that public sector institutions will remain very important and it would not be rational to absolutely replace them by a massive introduction of private institutions and establishments in all Arab countries. Not only because of the uncertainties of a contribution to higher education by the private universities, but also because of the potential failure of private universities when deviating to targeting mainly business and profit objectives instead of focusing on targeting the conventional intrinsic values of higher education.

In the field of science policies, the structure of R&D systems and the distribution of R&D institutional units remain limited. The public sector, including universities, is responsible for most R&D activities. It contributes 94% and 93% of total R&D institutions in Mediterranean and Gulf Arab countries, respectively. The private sector accounts for only 6% and 7% of total R&D institutions in Mediterranean and Gulf Arab countries, respectively. The same trend is true of the distribution of human resources available to R&D institutions, which is defined by the number of full-time equivalent (FTE) researchers.[35] The vast majority of FTE researchers are employed by public sector institutions, accounting for 99% and 97% of total FTE researchers in Gulf and Mediterranean Arab countries, respectively. The private sector’s employment of FTE researchers is correspondingly low. The Gulf countries appear to be relatively more dependent on the public sector than the Mediterranean countries in terms of public R&D

[35] The concept of full-time equivalent researcher is adopted by UNESCO statistics on R&D personnel.

institutions, while the opposite is true concerning FTE researchers.[36] These findings make it clear that in both Gulf and Mediterranean Arab countries, most FTE researchers are allocated to, and most R&D and S&T activities take place within, the public (i.e., university) sector. The private sector has negligible contributions to total R&D activities. But it is worthy to note that private universities and the involvement of private companies by promotion of R&D is something very different. The differences between research conducted in private universities and the involvement of private companies by promotion of R&D can be explained in terms of type, objective and role. For instance, private companies often conduct limited applied type of research, dedicated to development and demonstration, bringing incremental innovations in order to develop products and processes that work, and that will reach the market. Public and private Universities are often able to manage a fuller spectrum of modes of research: from basic to strategic and applied. They have by far the largest staff, often well-qualified and as a rule obliged to carry out original work. The role of research in Universities is that it should be part of the training of professors and researchers, namely to enhance the quality of training and ensure the reproduction of the academy. University research was indeed an asset for the quality of training, but the role of university is not only to train future academics and researchers, but also to upgrade the knowledge and to train all sorts of highly-qualified technicians, technical workers and managers whose knowledge will remain relevant on a long-term basis. Furthermore, university research is part of the professional ambition of academics: it is their way to keep themselves up to date, to remain informed of the advancement of world science and to gain a sense of the technological stakes. Moreover, university research gives institutional credibility to the establishments; it is also a way to enhance the social mission of the university in its region, through “clusters” of collaboration with local users. Finally, university research may lead to a long-lasting, national reputation of quality, including in branches which become known for a speciality. Research conducted in Public National Centres are generally specialized in specific spheres of public interest (agriculture, nuclear and space technologies, health) with a continuum from basic to applied research. They are often favoured by

[36] See S. Qasem, Research and Development System in the Arab States: Development of Science and Technology Indicators, 1998 (Cairo: UNESCO, 1998).

governments, which give priority to their funding because they contribute to (nationally) strategic areas and are commissioned to generate more practical outcomes.[37]

Apart from the differences in the nature of research conducted by different institutions, it is worthy to note the vital role of the public research institutions. It is worthy to note that the presence of private sector and the shortcomings in the performance of the public institutions and government interventions however should not hide the fact that public sector institutions will remain very important and it would not be rational to absolutely replace them by a massive introduction of private institutions and establishments. Not only because of the uncertainties of a contribution to research by the private universities, but also because it is worthy to note that the status of science and scientists is much better in the Arab countries (especially in Maghreb: See UNESCO) than in other parts of the world (e.g Africa, See STS)[38] where neo liberal policies have lead to the withdrawal of governments' support, the collapse of renowned establishments and the ruin of the profession - while such a deinstitutionalization and the replacement by a global market of scientific skills had no results or disastrous ones in terms of scientific publications. Moreover, the bibliometric data demonstrate that the "newly founded" private establishments in the Arab countries contribute very little to the research output of the country, and that most of them do not care at all about research. (See ESTIME). The production of publications derives from some public establishments and very little from industry or from private universities (with the exception of three or four ancient and proud research universities like AUB or St Joseph in Lebanon; and to some extent AUC in Cairo)). For instance, according to UNESCO (2006) in spite of seemingly adverse conditions (underexploited potential, hesitations about the function of research and the support it deserves) the output is growing, at least the number of articles published in high-quality international journals. Production is modest but steadily and (sometimes) greatly growing, the whole zone progressed significantly during the twenty last years, while almost invisible before the 1990s, it now contributes to 1% of the world production. This is a modest but meaningful change. The growth was quicker than in the

[37] See Johann Mouton and Roland Waast, 'Comparative Study on National Research Systems: Findings and Lessons Learnt' Chapter 5 in V. Lynn Meek, U. Teichler & M-L Kearney (eds), Higher education, Research and Innovations: Changing Dynamics, Report on the UNESCO Forum on Higher Education, Research and Knowledge 2001-2009, Kassel: Kassel University (Incher-Kassel), (2009), 165-166.

[38] See Roland Waast, 'Science in Africa: From Institutionalisation to Scientific Free Market - What Options for Development?' Science, Technology and Society, 8(2), (2003) 153-181.

rest of the world –especially the developing world. The movement was not the same in different sub zones. Egypt progressed slowly during the 1980s and even stagnated during the 1990s. Since 2000 it has regained momentum and this is linked to a new leap forward of the number of students (and staff in the universities). Machreq went at a quicker path; but this is especially true in Jordan (which almost doubled its participation in the world science during the last decade) and in Lebanon (after the civil war and thanks to numerous foreign cooperation). However the most remarkable feature is the spectacular growth in Maghreb production. Within the last fifteen years Morocco more than doubled its participation in articles published by the best international journals (nearly 1 000 participations each year), Algeria did the same in spite of a six years civil war. Tunisia shows the most constant and powerful growth, it almost tripled the number of its publications in the last decade, and the growth is accelerating since the new structuring of research and its nurturing by the state (1998). On the opposite side, the Gulf countries are stagnating (as well as Saudi Arabia) except for the countries (Emirates and Qatar) which imported foreign campuses: thanks to these contributors their scores increased tremendously but they remain modest (200 to 400 participations per year). All in all Arab countries have doubled their number of participations in the world science (and increased their world share). They owe it principally to a fit of enthusiasm in Maghreb during the last two decades.[39] These findings are consistent with the results presented in ESTIME (2006), which indicates that the Mediterranean Arab countries show a relatively small participation in the global production but a growing and dynamic production. According to ESTIME (2006) figures based on Science Citation Index (SCI) (2006) database indicate that SCI Scores in Egypt, Tunisia; Morocco and Algeria are 2743; 1079; 756 and 728 respectively, while the percentage shares in world publication production (%) in 2004 are 3.42; 1.08; 1.26 and 0.73 respectively. According to ESTIME (2006) even if the Mediterranean Arab countries participation to world science is limited in quantity, it gives these countries a good position in Africa. After South Africa, Egypt and Tunisia then Morocco closely followed by Algeria, have a good record of publications. Apart from Syria, smaller players like Lebanon and Jordan have also an honourable record of publications. In contrast to UNESCO (2006), ESTIME (2006) indicates that the Gulf

[39] See UNESCO, (2006), op. cit. note 6, 48-49.

countries or Saudi Arabia are also close in terms of quantities of production. According to ESTIME (2006) over the period (2001-2006) the growth in the shares of world publication production for Morocco; Algeria; Tunisia; Egypt; Jordan; Lebanon and Syria is estimated at 0.98; 2.0; 2.05; 1.23; 1.60; 1.35; 1.33 respectively; the growth in the shares of world publication production over the period (1999-2004) is estimated 4; 48; 63; 14; 17; 49 and 1 respectively and the growth in the shares of world of publication production over the period (1993-2004) is estimated 100; 89; 125; 5; 94; 250 and 18 respectively… the growth pattern in the last twenty years is dramatic and impressive, their growth rates are always above the world growth of publications and comparable to the three countries chosen as "control group" (Chile, Thailand and South Africa). The whole region was still invisible to computation some twenty years ago and represents today nearly 1% of world production. The main cause for this growth is the extremely strong growth of Maghreb countries. Morocco has had a previously stronger and longer growth period. Finally, only Tunisia has been constant in its support to research and technology and inventive in the manners it can consolidated research and finance it.[40]

These findings imply that in order to enhance science policies in the Arab countries, restructuring efforts should provide incentives to sustain institutional reform, strengthening public institutions, offering further financial support to R&D and science policies, building capabilities and enhancing scientists and engineers and R&D personnel.

COMMON FEATURES AND DIVERSIFIED FEATURES OF SCIENCE POLICIES

It is worthy to note that in the Arab countries, there are several common features and also other diversified features of science policies. For instance, the first common fact about science and research in the Arab region is that there is a long tradition of research in Egypt (Cairo university: 1908), but some countries in the Near East have old and worthy establishments which go on playing a major role in their scientific achievements in Lebanon (the Saint Joseph University: 1875, and the American University of Beirut: 1867) and in Syria (the Damascus University: 1903). Elsewhere the foundation of Universities is recent, beginning with independencies and aiming to train the managerial

[40] See ESTIME (2006), op. cit. note 6, 29-31, www.estime.ird.fr

staff much needed after most of the colonial executives left. In all cases Maghreb (due to a late colonisation) was clearly behind Machreq at the beginning of the 1960s, and Machreq and the Gulf behind Egypt. But the main institutionalisation of science remains everywhere a recent one (dating back to two or three decades). The second major common feature is that even when there is a long tradition of research (Egypt), the social inscription of science remains unsteady. The societies are strongly framed by communities, lineage relations and religious belief. Furthermore, the political sphere is dominant. Maghreb is somewhat different, as research has become part of the role model of respected professions. In all Arab countries, "social factors play a big role in impeding scientific research or limiting its efficiency". The third major common feature is that in the Arab countries most of the research policies are based on limited set of institutional arrangements based on "academic-plus-public-research" institutions. Evidence for this common feature on institutional pattern appear in the Mediterranean Arab countries which implies that most of research is done in universities by individual researchers and next this is followed by public research institutions, with exclusive public funding, public research institutions are rarely related institutionally to the universities and they have been created by the state for the promotion of its own policies, like the modernisation of agriculture or public health services. This common institutional arrangement implies the two different models of either a coordinating institution that is independent from the performing institutions, mainly in Machreq countries, or coordination institution that is dependent on the heading of research, mainly Maghreb countries, where the ministerial body decides upon budgets both for programmes and salaries and the tutelage model keeps subordination of funding and governance under the same central Ministry. This third fact on the state support to science implies that either as a symbol of modernization (Gulf), of rationality (Tunisia), of uniting the people under a nation state (Syria), or because it was part of the development model (Nasser: Egypt) many governments at one time or another granted strong support to the blossoming of tertiary education and research (especially in sciences). A general characteristic of the region is that the support of the state may be powerful, but it has ups and downs, it depends on the regime, the fractions in power, and there were indeed many turnarounds, Algeria is a good example. In many places it is discreet (Machreq and the Gulf) but it should be acknowledged that

almost everywhere the state did a great deal for research through regulations (especially the subordination of promotion in academic careers to some research work); and with few exceptions (Egypt and Algeria), governments never ill-treated the profession. An (alternative) support for science lies in professions. This is notably the case again in Maghreb. Professional groups that did not exist before independence have developed quickly. They maintain proudly high standards and they have integrated research into their role model. The common characteristics of institutional arrangements in the Arab countries imply that science has no clear function inside the society; they seem to have attributed functions but they are not distinguished from educative purposes; public research is not used in a collective way. ESTIME indicates that the consequence for this absence of interest for science is also an absence of interest for some fundamental aspects in research, an absence of collective understanding for science, and an absence of capabilities inside firms and public institutions to grab the inner making of life and matter…science seems to be unattainable to most engineers in firms or public institutions in the Mediterranean countries, because they lack the means of scientific research.[41]

The common features identified above should not hide the fact that there is a great variety among Arab countries. So, apart from some common features identified above; it is useful to explain the diversity in policies toward research, science and education in the three sub-zones: the Gulf countries, Machreq and Maghreb. Egypt is a case by itself. The first variation finds their sources back in some historical peculiarity and structure. for instance, [the Gulf countries adopted an "anglo-saxon model"]; Maghreb countries designed under the French rule; Egyptian Academy of S&T was created on the blueprint of the Soviet Academy of Science; the large variety of universities in Lebanon goes back to the religious community history (and policy) of the country. After gaining independence, most of the Gulf countries adopted an "anglo-saxon model" with elite universities, and research programs in experimental sciences (widely open to collaboration with foreign countries – mainly USA and UK). In human and social sciences, research programmes were on the contrary "closed" (reserved for local language and scientists). [42] In both cases a pragmatic science expanded, connected to local problems: chemistry, biotechnologies, computer science; sociology, micro

[41] See ESTIME (2006), op. cit. note 6, 35-37, 41-43; see also UNESCO (2006); op. cit. note 6, 29-32.
[42] See ESTIME (2006), op. cit. note 6, 41.

economics, and Islamic philosophy or law. Research is not here of real need (for the economy depends on royalties from oil and linked remittances), but rather the investment of Universities. It has been funded by some states, and numbers of Foundations. It is mostly operated by foreign professors, sometimes by prestigious invited visitors, who were hired in greater and greater numbers as the Universities increased significantly. Egypt (and other countries in the Near and Middle East like Iraq or Syria) set up a mass education system, including tertiary education, with a view to train the technical workforce needed by their development model (mass production for internal market). As this “Fordian” model failed they entered hastily in a reconstruction of the education system. Private Colleges and Universities proliferated while the public establishments, overcrowded and ill funded, lost quality and their staff suffered a drop in status and wealth (especially in Egypt). National Institutes (outside Universities) are important performers here. But their budget was reduced and they have now to become more and more self-financing. In the Near East (Jordan, Lebanon) though no “Fordian” ambition prevailed, they seem more dependent in private sector as most Universities are private ones to serve their internal very small market, there are almost no national research centres, except small ones in very specific areas. But University laboratories depend on private Foundations. There are a few “research universities” (like AUB in Beirut or JUST in Jordan) or reputable Foundations (like the Royal Scientific Society in Amman). Maghreb is different, though latecomers, Morocco, Tunisia and Algeria established quickly mass universities of quality throughout the country (after 1985), and a number of prestigious Polytechnics (selective, for all sorts of engineers). They set up in parallel national centres for research in various fields. Their model (institutional and intellectual) draws inspiration from Europe (especially from France) and intensive scientific cooperation has unfailingly supported their activities. State control is strong; governments are secular and nationalist with a technocratic ethos, they launched and financed the system without the private sector managing. There is some R&D in enterprises (more so in large state owned ones, especially in Algeria). Tunisia was most constant in its support to science, and has recently developed a full set of institutions framing research, which is lacking elsewhere. The second differences appear in the type of governance and policies, as there are two different approaches to the governance of

science; they lead to different strategies; and in all cases the function of science remains questionable, and the research system is fragmented. The first approach is the centralised governance or grassroots initiatives, the second approach seem to be more decenteralised with involvement of several performers, there is a great difference between the two main approaches. In (Egypt and) the Maghreb, there is a strong role of the state in the management of the research sector, formulation of policy and the strategy, issue regulations, legislation, institution building, instructions to the establishments likely to do some research (Universities, Centres) and budget grants as government funding is the main resource for research. Its arms (Agencies or National services) take action, implement the measures and monitor the situation. The second approach is quite opposite. It prevails mainly in Machreq and the Gulf countries. The performers are most important (Universities, enterprises – there are few Research Centres here). Activity relies on their initiatives and on their decision to take part or not in research, according to their own interests. National bodies in charge of science are often independent (though their budget almost totally comes from the government). ….The most remarkable bodies can be found in the Gulf countries. They are generally very new, and they consist in Agencies or Foundations whose objective is in particular to attract foreign capabilities and R&D firms from abroad, for example in Emirates; Qatar (Qatar Foundation and Qatar Science and Technology Park) and Kuwait (the Kuwait Foundation for the Advancement of Science). Egypt has a mix of centralised governing public bodies (the Academy of Sciences and other Ministries) and of some powerful performers (like the National Centre for Research, and various prestigious (AUC) or huge Universities – Cairo University being the largest). The third fact is the different strategies, the difference between governance modes leads to different strategies. For example, in Maghreb countries (and Egypt) there is a clear awareness of the necessity to develop first a solid national science base. This means first basic science (and they have developed a whole range of capabilities in all sorts of specialties in hard and engineering sciences) then drawing it toward applied or strategic research and linking it to the productive sector. Moreover, the commitment of Maghreb countries appears especially from the elaborate institutional framework designed for research by Tunisia (nationally labelled research teams or laboratories, commissions for their evaluation, significant resources reserved for

them -whether they are made up of academics or of researchers belonging to centres or to industry, or of a mix of them provided each of them is active in research. In Machreq countries, on the contrary performers are free of their initiatives, (and very often let alone with their own means or unwillingness to take part in the game). The Gulf countries are an extreme case. Their own strategy does not aim at building on a national science base; but at localizing on their territory the best foreign capabilities, and innovative R&D firms. Emirates and Qatar are building giant premises for next "knowledge Universities" to come. Qatar has attracted campuses of Carnegie Mellon, Texas A&M, Weill Cornell and other leading universities. First members of the Qatari Science & Technology Park were "EADS, ExxonMobil, GE, Microsoft, Shell and Total. By bringing research and business together, QSTP is delivering Qatar's vision for a knowledge economy". Emirates is successful with Abu Dhabi chapter of the Sorbonne, University of Wollongong or Westfield University and the brand new American Universities of Sharjah. Emirates established in 2003 a Knowledge Village (KV) in the Dubai Free Zone for Technology and Media. It houses more than 200 companies and institutes for training and education in fields such as computing, technology, business management, life science, fashion and media". A Dubai Academic City (DAC) is now marketed as 'a new global fully integrated academic destination'. This is an innovative strategy, looking ahead and fitting small countries. It looks like that of Singapore days ago. The main question is whether this new strategy is a sustainable one; or a purely commercial (and rather: financial) one. New campuses are designed to compete with the best old Universities in the region (AUB) and elsewhere. They are supposed to attract a number of rich and brilliant students; and their assessment is by now much more in terms of profitability than of substantial contribution to education and knowledge. The same is true for R&D firms: no substantive industrial strategy is yet linked to their arrival.[43]

The Arab Knowledge Report (2009) indicates that based on the analysis of the available data on research and innovation practices and outputs, Arab countries can be classified in one of three models. Model one: Countries whose research centres are characterised by a highly centralised administration and a bureaucratic relationship with the public sector. The funding for these research centres is limited to state contributions,

[43] See UNESCO (2006); op. cit. note 6, 33-38.

and they show no diversity in their financial or human resources. The missions of these research centres and their programmes are burdened with scientific services required by public utilities. As such, their contribution to the production of original research and patents are limited and they do not include all scientific specializations (Syria, Libya, Algeria, Sudan). Model two: Countries whose centres are characterised by flexibility in their relationship with the public sector and diversity in their funding sources and human resources. Their most significant research production, however, remains within the institutions that are able to draw international support and build partnerships with industry . The institutions within this model show promising dynamism, yet they are also characterized by the frequently brief tenure of their experts and their intensive domestic and international travel (Tunisia, Lebanon, Jordan). Model three: Countries whose centres are characterised by flexibility towards, and sometimes independence from, the public sector, as well as by diversity of funding sources, and the ability to attract specialists from abroad and guarantee the relative stability of national specialists. A significant percentage of their scientific production comes from universities and private centres, and they are able to benefit from international cooperation programmes and from partnerships with service and industry sectors, as well as from independent national support funds (the UAE, Qatar).[44]

The above mentioned facts on the variation in science and research policies in the Arab countries can be interpreted along with the increasing debate in the literature. For instance, the conventional view in the literature is that the development of science, technology and knowledge is positively correlated with the level of economic growth. However, there is a considerable and increasing debate in the literature that national wealth and investment in science is indeed a necessary but not a sufficient condition for sustainable S&T development. For instance, according to Mouton and Waast the decline of a country in “world scientific capacity” is correlated with that part of the national wealth which is invested in research and development, as well as with the number of researchers in proportion to the population. But these correlations are not perfect, and there are other factors to explain the development of science than scientific investment and workforce size. Mouton and Waast investigation of the roots of inequality of the

[44] See Arab Knowledge Report (2009): Chapter 5: op. cit. note 6, 188-189.

fifty-two countries [including eleven Arab countries] has explained that significant inequalities in world science have developed, and still exist due to many factors. This explanation is very useful and relevant to interpret the variation across the Arab countries. The first factor is that the development of science depends on the history that plays its role. For instance, in Africa [and the Arab region], the two main producers (South Africa and Egypt) are countries which have also been engaged in the development of a national science base for more than a century, and were only "semi-colonies". It must be stressed that sometimes the historical role lays less in "whole countries" than in specific establishments, examples of these could include the Saint Joseph or American University in Beirut. In most places there is a specific role for a few establishments, and often the oldest are the most attached to high standards. The second factor is that the size of a country is not the decisive factor in scientific production but the development of science depends on past and present development strategies that have powerful and enduring effects; Singapore is a good example of a clear link between the development of science and industrialization. The nationalist governments that tried to develop import substitution, even when they failed in that plan, generally established a science base which remains a national asset for the country (see Brazil, Egypt for some time, the Maghreb countries and a number of others). The third factor is that the development of science depends on the trust in science, as there must clearly be some pact (at least an implicit one) between science and society. This was the case in Asia, Egypt, Latin America and South Africa during Apartheid. In developed and developing countries [science] was the source of progress for humankind; its support was the duty of the state; and its results should be public goods. This implies that there be some general consensus (or debate) about the uses of science and the pursuit of innovation, which implies energetic support from the state for "strategic" and applied research, organized in "clusters" in collaboration with dynamic firms. Tunisia has made great efforts, and some Gulf countries are now offering excellent facilities to international enterprises and universities, in order to attract and territorialize them. The fourth important factor is that the development of science depends on the enabling social environment of science [social values including; political power; material wealth; religious values; the family; etc.], which is an important component of the motivation of scientists and may also

predominate and override all other considerations. Some nations have traditionally held science in high regard, such as Egypt, India, Thailand and Viet Nam, others have not had such traditions, or they have another understanding of what valuable knowledge is. These tendencies may well interfere with a commitment to science and its standards. The fifth factor is that the development of science depends on the popularization of science that requires constant support and effort from the scientists themselves to develop role models and promote the understanding of science and also needs appreciation within epistemic communities for different kinds and levels of science: pure; theoretical, applied, development and action research. The sixth factor is that much of the development of science depends on the volume of staff (in countries and establishments) or adequate availability of human capacity and scientific capital and talented individuals persons engage in generation of knowledge. The number of researchers per million people is an index of the interest of the government (and of the people) in the development of the human capital base of science. In the Arab countries, there are great differences between countries in the way they dealt with the scientific profession, for instance, in Tunisia and Morocco the profession remained a good and respected trade, while in Algeria and in Egypt researchers have been ill-treated depends on the political regime, the power of academics' trade unions, the support of socio-cognitive blocs, the type of economy and the national development strategy. [In the Gulf countries the high appreciation of science probably appears in the highly competitive salaries offered to academic staffs in the universities and professional workers in the fields of, medicine, science and engineering]. The seventh factor is that much of the development of science depends on the will and interest of the government, ambient values, and international support. For instance, emerging countries (or "candidates emerging", like Egypt) are increasingly investing in the development of original research. In Maghreb countries there is a firm commitment to research and its own sophisticated institutional organization (Tunisia is the best example), by contrast in most of the Machreq countries such policies do not exist (or have no priority). The data shows real dynamism of "intermediary countries" such as the Maghreb countries, the results seem to confirm, that these countries are creating a reservoir of new wealth. For instance, the distribution and list of countries according to their publication output and growth over the Twenty-year Period (1987-2006) show diversity between

Arab countries. For instance, the rank in descending order by size of research output as measured by the number of publications per year (2006), implies that the candidates emerging countries such as Egypt is producing (2,000 -- 6,000); this is followed by intermediary countries such as Saudi Arabia; Tunisia; Morocco and Algeria which are producing (600 -- 2,000), this is followed by intermediary countries such as Lebanon; Jordan; Emirates and Kuwait which are producing (200 -- -600), and intermediary countries such as Oman and Syria is producing (100 -- 200) and finally small science countries such as Qatar; Bahrain and Sudan which are producing (60 -- 100).[45]

NATIONAL, REGIONAL AND GLOBAL INFLUENCES ON HIGHER EDUCATION AND SCIENTIFIC RESEARCH

The linkages between higher education and scientific research in Arab countries are strongly affected by national, regional and global forces that shape the linkages between higher education and scientific research.

LANGUAGE POLICIES

To start with, national language policies play an important role in determining the prospects of scientific research within higher education. For instance, in the case of Syria, Arabization policies aim to make knowledge accessible to all strata of the population, not just to a small 'colonial' elite. Nevertheless, in the case of engineering education, according to Hanafi Arabization policies produce professionals handicapped by the scarcity of translated books. Further, engineers experience great difficulty in remaining professionally up-to-date. As a result, the Arabization of the sciences, while promoting an agenda of 'decolonization', paradoxically reinforces Syria's dependence on the former colonial countries in terms of the engineering sciences and technological know-how. This problem may go unresolved given the limited financial resources of scientific institutions in Syria and in the Arab world in general. The paradigm behind the politics of Arabization in countries such as Syria and Algeria is the substitution of foreign languages

[45] See Johann Mouton and Roland Waast, (2009), op. cit. note 39, 149-150, 153-158. Data on Science Citation Index (SCI) for 2006.

(French, English) with Arabic. [46] By contrast, the Tunisian experience is somewhat different as the state imposes Arabic only on certain parts of the curriculum. At the same time, Tunisian students must be proficient in French, and sometimes even in English, to remain current with foreign sources and textbooks.

STUDENT ENROLLMENTS

The growing influence of private and foreign universities across the Arab regions exerts its effects too on scientific research, particularly in Gulf Arab countries where the share of foreign universities in science and engineering faculties and institutes stands at approximately one-third of the total number of such faculties and institutes. Moreover, international organizations enroll 18% of all foreign students and 45% of all foreign staff in Gulf universities over the period 1995–2001 and 1995–2002, respectively.[47] The importance of private foreign universities in the Gulf can be explained in the context of larger attempts to restructure and diversify the economy, particularly in the UAE. The prevalence of private foreign universities in the Gulf Arab countries parallels their heavy reliance on imported labour while their Mediterranean counterparts rely to a greater extent on the export of labour.

The influence of international (foreign) institutions on higher education in the Arab countries is also reflected in the data on the international mobility of Arab students.[48] Over the period 1999–2002/2003 the number of students from Saudi Arabia, Qatar, Oman, and the Gulf region generally who studied in the USA declined by 31 per cent, 26 per cent, 25 percent, and 27 per cent respectively in the aftermath of September

[46] See Sari Hanafi, 'The University Education of Syrian Engineers', International Higher Education, Winter, (2000) at http://www.bc.edu/bc_org/avp/soe/cihe/newsletter/News18/text13.html, accessed 20 February 2007.

[47] Adapted from Gulf Statistics, 'Statistics on Higher Education in the Gulf Countries' (website) (2006). See the Cooperation Council for the Arab States of the Gulf Secretariat General, 'Education and Health Services Statistics,' in Statistical Bulletin (Riyadh, Saudi Arabia: Secretariat General, Information Center, Statistical Department, 2005). See especially Table 38 at http://library.gcc-sg.org/StatisticBulletin2005/pg79.htm, accessed 20 October 2006, and Table 39 at http://library.gcc-sg.org/StatisticBulletin2005/pg83.htm, accessed 20 October 2006. Further, according to the University of Wollongong in Dubai (UOWD) website, the UOWD hosts over 2,200 students from 80 different countries. According to the American University in Cairo (AUC)(Egypt) catalog (2006-2007), around 32.4% of students are from the US and 8% are from other (other nationalities, not specified) countries, while the remaining 59.5 or 60% are Egyption (*See AUC Catalog 2006-2007, The University Profile Fall 2005 (Cairo:* the Printshop of The American University in Cairo, June, 2006) *21)*.

[48] According to UNESCO-UIS Global Education Digest (2006) definition, international (or internationally mobile) students are "Students who have crossed a national or territorial border for the purposes of education and are now enrolled outside their country of origin." See http://www.uis.unesco.org/glossary/Term.aspx?name=International%20(or%20internationally%20mobile)%20students&lang=en, accessed 20 October 2006. See also Table 17 at http://stats.uis.unesco.org/TableViewer/tableView.aspx?ReportId=217 and Table 18 at http://stats.uis.unesco.org/TableViewer/tableView.aspx?ReportId=218, both accessed 20 October 2006.

11, 2001.[49] This has emphasized the need to restructure domestic public higher education institutions and the expansion in the number of foreign private higher education institutions operating within the Gulf. Moreover, Table 2 shows that the UK, US, France, Germany, and Australia receive around 74% of all international Arab students, 54% of international Gulf Arab students, 82% of international Mediterranean Arab students, and 50% of the other non-Gulf-non-Mediterranean Arab students.[50] This implies that, with regard to the distribution of internationally mobile students from the Arab countries, the majority of Arab students in the UK, US, France, Germany, and Australia are from Mediterranean (68%), Gulf (20%), and other non-Gulf-non-Mediterranean Arab (12%) countries. These students are overwhelmingly men, given the restrictions imposed on women who wish to travel abroad, particularly in the Gulf countries. This has implications regarding the marginalization of women, particularly those who wish to access S&T disciplines or fields within and across the two regions.

Insert Table 2 here

It is worthy to note that intra-regional mobility of students, between Arab countries, is significantly weaker than the international mobility of Arab students (see Table 2). Regional mobility within the Arab region is generally limited to Jordan and Morocco. For instance, of all Arab students only 3% move to the Gulf countries, 1% to the Mediterranean countries, and 3% to other non-Gulf-non-Mediterranean Arab countries; in total, only 7% are moving in all Arab countries compared to 73% moving to the USA, UK, France, Germany, and Australia. Among all Arab Gulf students only 3% move within Gulf countries, 0.3% to Mediterranean Arab countries, and 7% to other non-Gulf-non-Mediterranean Arab countries; this amounts to 10% moving to any Arab country compared to 54% moving to the USA, UK, France, Germany, and Australia. Similarly, among all Mediterranean Arab students only 1% move to Gulf countries, 1% within Mediterranean countries, 2% to other non-Gulf-non-Mediterranean Arab countries; only 4% move to any Arab country compared to 82% moving to the USA, UK, France, Germany, and Australia. Among all other non-Gulf-non-Mediterranean Arab

[49] See UNDP-AHDR (2003), op. cit. note 4, Table 1, 23. See also Muysken and Nour, op. cit. note 5, 971.
[50] These proportions are less than that of Korea (95%) but higher than those of Singapore (36%) and India (37%).

students only 11% move to Gulf countries, 4% to Mediterranean countries, 7% within the other non-Gulf-non-Mediterranean Arab countries; thus 22% move to any Arab country compared to 50% moving to the USA, UK, France, Germany, and Australia. These findings on weak intra-regional mobility within the larger Arab region are consistent with the findings of Zahlan, who found weak cooperation in scientific research and scientific publications among Arab countries.[51]

COOPERATION IN SCIENTIFIC RESEARCH

Political and ideological conflicts, restrictions imposed on political participation, and the lack of political stability, freedom, democracy, rule of law, and good governance sometimes might hinder the effectiveness of policies aimed at restructuring higher education and scientific activities in the regions. Since most scientific and higher education institutions (i.e., universities) in the Arab region rely on the public sector, they often feel the negative effects of bureaucracy, institutional rigidity, and lack of transparency. Their reliance on government resources sometimes requires that they fall under the direct control of the ruling regime and implement policies consistent with prevailing political ideologies. Scientific and higher education institutions sometimes suffer from a lack of autonomy and freedom, and also often from a lack of funding that prevents them from implementing sound, systematic, and scientific plans. Arab countries must encourage private sector participation and the implementation of comprehensive institutional reforms aimed at creating an environment conducive to policy restructuring. Sometimes the autonomy of higher education and scientific institutions must be encouraged, along with the strengthening of political participation, political stability, democracy, freedom, rule of law, and transparency in governance. Private sector

In his pioneering empirical study, Zahlan found very limited cooperation in scientific policy and research endeavours in both the Arab Gulf and Mediterranean countries, as measured by the number of joint or co-authored publications among scientists.[52] For instance, he found that in 1990, co-authorship of scientific papers within the Gulf countries accounted for only 1.4% of all co-authored papers; this increased to 3% in

[51] Zahlan (2000), op. cit. note 11.
[52] Ibid.

1995.[53] On the other hand, scientists in Algeria, Morocco, and Tunisia produced 1,205 publications in 1995; of these, 769 were co-authored with scientists outside their own countries. Surprisingly, only 11 (of the 769) involved scientists from two Maghreb countries, and only one (of the 11) did not involve an OECD partner.[54] From Zahlan we also learn that there is only limited scientific cooperation and co-authorship of scientific papers between and within the Gulf and Mediterranean countries. The Gulf countries' scientists' cooperation with other Arab scientists tends to be limited to a few Arab countries. Egypt is the major Gulf partner, probably because of the prevalence of Egyptians employed in scientific and higher education institutions in the Gulf. The limited cooperation with other Arab scientists also holds for the Mediterranean countries. According to Zahlan, 'joint co-authorship with non Gulf Arab countries merely reflects the fact that Gulf countries['] universities employ professors from other Arab universities. … On the other hand, the cooperation between Maghreb countries and other Arab scientists accounts only for 3% and 3.5% of total joint published papers in 1990 and 1995 respectively'.[55] Moreover, ESTIME (2006) provides more up-date analysis of the increasing international collaboration and the degree of internationalization of S&T activities that can be measured by SCI co-publications or co-authors in scientific publications in the Mediterranean region (2004). According to ESTIME (2006), however, cooperation through co-publications, most importantly co-authorships patterns are very different from one country to the other, Egypt (with 32% of co-publications), and Jordan (37%) have, in relative terms, less co-publications with a foreign country; Lebanon (48%) and Tunisia (49%)-which both have many co-publications with France-are less "open" in relative terms then Morocco(60%) and Algeria (65%).[56]

Until recently, the Gulf Arab countries also have limited cooperation with foreign institutions.[57] In contrast, their Mediterranean Arab counterparts have significant cooperation with foreign institutions. In particular, the Maghreb countries cooperate significantly with the OECD countries. For instance, the joint papers of the Maghreb-OECD countries account for 90% and 81% of total joint publications in the Maghreb

[53] Ibid.
[54] Ibid., 15.
[55] Ibid.
[56] See ESTIME (2006), op. cit. note 6, 32-33. Figures for SCI are obtained from SCI/Thomson, Calculations: P.L. Rossi/IRD
[57] Ibid.

countries in 1990 and 1995, respectively. Among the OECD countries, France has the highest level of cooperation and share of co-authored papers with Algeria, Morocco, and Tunisia. Maghreb-France cooperation accounts for 67% and 62% of total joint papers in 1990 and 1995, respectively.

Clearly, despite similarities in religion, language, culture, and traditions, higher education cooperation and scientific cooperation are limited within and between the Gulf and Mediterranean Arab countries. In contrast, broader international scientific cooperation is relatively more active and strong for some Mediterranean countries, although still very limited for all Gulf countries. Zahlan argues that scientific workers in the Maghreb, on an individual level, have become deeply integrated into the international scientific community. They do not appear, however, to have become integrated into their national or regional economies or societies. It is clear from the data that the level of cooperation within the two regions remains extremely limited.[58]

We can interpret the findings with respect to active cooperation with OECD countries (particularly between Maghreb countries and France) to proximity in terms of geographical location, old colonial relations/ties, and post-colonial S&T cooperation (see the paper by Djeflat, in this issue).[59] Moreover, the Maghreb countries were also in both S&T contracts and scientific cooperation with the European Union more than all other Mediterranean countries taken together.[60] In particular, France remains the major destination for postgraduate students from Maghreb countries.[61] Algeria, Morocco, and Tunisia still depend heavily on France in a number of ways related S&T, including in terms of higher education and scientific cooperation. In contrast, and somewhat surprisingly, scientific cooperation between the two Arab sub-regions remains extremely limited, probably, due to prevalent differences in philosophy, structure, mode, type, style and aims of strategies of higher education and science policies in both regions. The major policy implication is that there is urgent need to strengthen Arab regional cooperation as an important component in the broader restructuring of higher education and science polices in the Arab region.

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[58] Ibid.
[59] See also the OECD (1997), op. cit. note 15; Waast and Krishna, op. cit. note 17.
[60] ESCWA, Science and Technology Policies for the Twenty-First Century (New York: United Nations, 1999), 7–209.
[61] Abdelkader Djeflat, 'Science and Technology Policy and their Implementation in the Maghreb Countries' in Economic and Social Commission for Western Asia (ESCWA) ESCWA Proceedings of the Expert Group Meeting on Science and Technology Policies and Strategies for the Twenty-First Century (Beirut, 10–12 March 1999) (New York: United Nations, 2000), 146–182.

REGIONAL INFLUENCES ON HIGHER EDUCATION AND SCIENTIFIC RESEARCH

The UNDP-AHDR (2003) and Arab Knowledge Report (2009) indicate the influence of several regional institutions on higher education and scientific research.[62] According to Arab Knowledge Report (2009) despite the lack of vision and institutional practice and despite the weakness of the legislative framework within which to promote the advancement of the knowledge society in the Arab region, there are many recent pioneering illuminating regional Arab institutions and initiatives in the field of science policies attempt to deal and engage in the issues of reform of science and higher education and to support research and development in the Arab region. These regional institutions includes regional agencies and regional pioneering successful Non-governmental (NGOs) initiatives represent shining examples of regional institutions attempts aimed at embracing, catalysing, propagating knowledge initiatives and participating in the building of a knowledge society in the Arab region. This includes for example, the Kuwait Institute for Scientific Research; the Arab Fund for Science and Technology Development; the Arab Science and Technology Foundation, and the Arab Academy for Science and Technology and Maritime Transport. For instance, the Arab Science and Technology Foundation (ASTF) is an independent, non-governmental, non-profit regional and international organization established in 2000 in Sharjah, UAE. It seeks to set up a network with similar organizations in Arab and other countries. To this end, ASTF created an equal-opportunity funding program designed to make scientific materials available all over the world, and to harness know-how in the Arab world. It seeks to coordinate the Arab countries' efforts in the fields of S&T, encourage scientific research and technology transfer activities, develop and mobilize human resources in support of S&T, and create links and networks between private and governmental sectors. Ultimately, the goal is to achieve sustainable development in the Arab countries. The organization is characterized by autonomy (financial independence), responsiveness (reacts promptly to the innovations and ideas), conversance (awareness of research needs and priorities), linkage (networks), flexibility (flexible organizational structure),

[62] UNDP-AHDR "Arab Human Development Report" (2003) op. cit. note 4, 105-107. Arab Knowledge Report (2009), op. cit. note 6, 84-86.

sustainability, credibility, and impartiality. In addition, in Jordon, for example, the Princess Basma Centre for Youth Resources founded in 2004 is known regionally for its vitality and creative and empowering curricula and it is launched the first INTEL computer club; INTEL is considered a pioneer in its attention to information technology and its use in development. Moreover, in Saudi Arabia, Mawhiba (Talent), the initiative of the King ‘Abd al-‘Aziz and His Men Foundation for Patronage of the Gifted has established a division to support and sponsor those with talent and Saudi inventors that has helped more than two hundred, introducing them to investors and issuing patents for their inventions. The foundation is working on setting up an invention incubator to develop and commercialise Saudi inventions. To this end, the foundation holds marketing sessions which bring together the inventor and relevant agencies from the private and public sector. Moreover, in the UAE, among the most important initiatives in support of knowledge and creativity has been the establishment in 2007 of the Mohammed bin Rashid Al Maktoum Foundation, a personal initiative of His Highness Sheikh Mohammed bin Rashid Al Maktoum, vice-president, prime minister, and ruler of the UAE, who allocated the sum of ten billion dollars as a knowledge endowment. The foundation’s goals are to develop knowledge and human potential in the Arab region and to use those potentials in the creation of a new generation of leaders able to support comprehensive development efforts all over the Arab world. A second initiative, “Dubai Giving,” is an extension of the first endowment. The foundation has also launched academic scholarships for studying abroad, such as the “Mohammed bin Rashid Al Maktoum Scholarship Programme”, which falls under the knowledge and education sector. The programme offers scholarships to the top universities of the world for qualified Arab students.[63] In addition in Qatar, the mission of the Qatar Foundation includes building capabilities, developing and preparing young people in Qatar and the region to face the challenges of an ever-changing world, the Foundation also aims to advance the State of Qatar to the point at which it can assume a leading role in educating for innovation and scientific research, the Foundation works on three axes: education (Education City), sciences and research (Science and Technology Oasis), and society in

[63] The website Dar Al Hayat, “The Mohammed bin Rashid Foundation and Elaf launch “Ma’rifa” electronic website”. http://www.daralhayat.com/science_tech/02-2009/Article-20090213-+7067573f-c0a8-10ed-0095-ef1792de150d/ story. html, on 14 February, 2009.

order to built technological and innovative capacity in Qatar.[64] Review of these Arab regional institutional initiatives reveals actions that truly aspire to strengthen institutionalism and fortify the supporting environment for the knowledge society. In addition these actions place us in uncharted territory: they neither cover all the domains of knowledge, nor do they reflect a clear policy for doing so. This said, since R&D expenditures in Arab countries is only about 0.2%, and the contribution of the private sector is almost absent, there is a critical need to establish new sources from both private and governmental sectors to fund scientific research projects in the Arab countries, as the efforts go much beyond the power of civic society organizations. Although the outcome and the sustainability of the option of depending on private and NGOs initiatives is probably somewhat sceptical, however, the above mentioned pioneering and illuminating Arab regional institutional initiatives represent successful shining examples of regional institutional attempts in the field of science policies aimed at engaging in the issues of reform of science and higher education and to support research and development, embracing, catalysing, propagating knowledge initiatives and participating in the building of a knowledge society in the Arab region.

CONCLUSIONS

Our analyses show that the interaction between higher education and science policies in the Arab region is complex and multifaceted. It is impacted by dynamic global, regional and national economic and political processes. Generally, Gulf and Mediterranean Arab countries lag far behind many emerging Asian countries in terms of both input and output S&T indicators. Moreover, most R&D and S&T activities in the Arab countries occur within the public sector (including universities), while the private sector makes only marginal contributions to total R&D (and thus to S&T) activities.

Notwithstanding, despite some similarities regarding S&T development in the two Arab sub-regions, there are significant disparities between them in terms of input and output indicators. Generally, the average performance for the Mediterranean countries is higher than for the Gulf countries in terms of most of S&T input indicators (both

[64] See the Qatar Foundation's website: http://www.qf.edu.qa/output/page40.asp.

financial and human resources). Moreover, higher education policies in the Gulf and Mediterranean Arab countries exhibit poor quality, insufficient demand (enrolment ratios in some of these countries), insufficient spending, and a biased structure of tertiary education in terms of student enrollments. This probably implies a complex causal relationship between the quality of higher education and science policies, a relationship mediated by political as well as economic, social and cultural (e.g., gender) factors.

While educational policies in the Arab countries have raised enrollment ratios and literacy rates they have failed to consolidate science policies which would bolster economic and social development. By and large, higher education and science policies have remained loosely-coupled, at best, particularly in the area of scientific research in most Arab countries, Maghreb is an exception, for instance, Morocco has had a rather high integration of both, Algeria and Tunisia also. This conclusion finds support in the conceptual framework presented by Marginson and Rhoades and which approach higher education over the backdrop of complex and imbricated local, national, and global forces.[65] In the Arab region, scientific research is affected not only by local and national processes but also by regional and global geopolitical forces. As such, reforming the linkages between higher education and science policies will have to restructure not only higher education institutions but also account for the broader political contexts that impact scientific research. Our conclusion that the Arab countries must restructure higher education and science policies, socio-economic, political and institutional contexts also find support in the argument presented by Johann Mouton and Roland Waast on the importance of science policies, socio-economic, political and institutional contexts.

This said, the application of the heuristic model developed by Marginson and Rhoades reveals some nuances in the way local, regional and global forces play out in various countries. The enrollment of tertiary education students is more directly impacted by national processes, while regional and global issues impact scientific cooperation in research and mobility of students across the region and internationally. Within this context, most probably, cooperation in scientific research (as measured by joint publications) is affected by patterns of student mobility. For instance, the concentration of collaborative scientific research between the Maghreb countries and France is best

[65] S. Marginson and G. Rhoades, 'Beyond national states, markets, and systems of higher education: A glonacal agency heuristic', *Higher Education, 43,* (2002), 281-309.

explained by the mobility of the Maghreb students to Europe (the UK, France, and Germany) and to the perpetuation of post-colonial ties between universities and research institutions. Generally, levels of regional cooperation are much weaker than cooperation with international partners outside the Arab region. This can be attributed partly to the poor quality and efficiency of Arab science institutions, as well as to complex bureaucracies, political rivalries and fragmentation, and to the lack of sound and consistent planning which could facilitate scientific cooperation.

Therefore, neither the Gulf nor the Mediterranean Arab countries possess all the human and financial resources necessary to promote S&T. The two regions need to improve their capabilities to enhance higher education and promote S&T research in the region. Our findings imply that in order to enhance science policies in the Arab countries, restructuring efforts should provide incentives to sustain institutional reform, strengthening public institutions, offering further financial support to R&D and science policies, building capabilities and enhancing scientists and engineers and R&D personnel. While privatization can be one way to strengthen the linkages between higher education and science policies, as has been the case in the Gulf, this path may not be the most secure way, since there is no guarantee that it will deliver high quality results. Private enterprises may choose to maximize the private return (profit) rather than the social return (efficiency, equity and quality) on their investments, thus not leading to an equitable distribution of new opportunities and longer-term projects. Another major limitation is that the lack of incentives may hinder private investment, since the provision of education and S&T research opportunities implies the presence of externalities (external effects). Apart from the differences in the nature of research conducted by different institutions, it is worthy to note the vital role of the public research institutions. It is worthy to note that the presence of private sector and the shortcomings in the performance of the public institutions and government interventions however should not hide the fact that public sector institutions will remain very important and it would not be rational to absolutely replace them by a massive introduction of private institutions and establishments. Not only because of the uncertainties of a contribution to research by the private universities, but also because it is worthy to note that the status of science and scientists is much better in the Arab countries (especially in Maghreb) than in other parts

of the world (e.g Africa,) where neo liberal policies have lead to the withdrawal of governments' support, the collapse of renowned establishments and the ruin of the profession - while such a deinstitutionalization and the replacement by a global market of scientific skills had no results or disastrous ones in terms of scientific publications. Moreover, the bibliometric data demonstrate that the "newly founded" private establishments in the Arab countries contribute very little to the research output of the country, and that most of them do not care at all about research. The production of publications derives from some public establishments and very little from industry or from private universities (with the exception of three or four ancient and proud research universities like AUB or St Joseph in Lebanon; and to some extent AUC in Cairo)). Not least, an absolute dependence on private foreign universities and scientific institutions may cause continuous dependence on foreign institutions, and may threaten the autonomy of national higher education, scientific, and even the stability of national and regional political institutions. Hence, at the regional level all Arab countries will be compelled to negotiate a contested and complex terrain. While they need improve active and effective national and regional scientific and technological cooperation and integration, Arab countries will also need to devise the proper political frameworks that would encourage the spread of a culture of cooperation, knowledge transfer, and the improvement of the quality and efficiency of higher education and scientific institutions. This will motivate S&T development and, consequently, long-term harmonious development in the region more generally.

Current regional initiatives in the field of science policies attempt to deal with some of the issues at stake, briefly mentioned above. A number of regional agencies and NGOs were founded to engage in the reform of science and higher education across the Arab region. For instance, the Arab Science and Technology Foundation (ASTF) is an independent, non-governmental, non-profit regional and international organization established in 2000 in Sharjah, UAE. It seeks to set up a network with similar organizations in Arab and other countries. To this end, ASTF created an equal-opportunity funding program designed to make scientific materials available all over the world, and to harness know-how in the Arab world. It seeks to coordinate the Arab countries’ efforts in the fields of S&T, encourage scientific research and technology

transfer activities, develop and mobilize human resources in support of S&T, and create links and networks between private and governmental sectors. Ultimately, the goal is to achieve sustainable development in the Arab countries. The organization is characterized by autonomy (financial independence), responsiveness (reacts promptly to innovations and ideas), conversance (awareness of research needs and priorities), linkage (networks), flexibility (flexible organizational structure), sustainability, credibility, and impartiality. This said, since R&D expenditures in Arab countries is only about 0.2%, and contribution of the private sector is almost absent, there is a critical need to establish new sources from both private and governmental sectors to fund scientific research projects in the Arab countries, as the efforts go much beyond the power of civic society organizations.

Another example is the Qatar Foundation founded in 1995 as an independent, chartered, non-profit organization committed to the development of Qatar and its people. It aims to create a network of centers committed to supporting education, science, and research, and promote community development. It does so by extending networks between itself and educational and research institutions and Arab scientists abroad. The Qatar Foundation's long-term goal is to develop a comprehensive plan of action that will address the need to raise the level of R&D (taking into account the available resources) to meet the development needs in the Arab region, and to improve collaboration to achieve immediate funding of scientific research and S&T in Qatar and the Arab region.

The initiatives mentioned above, some of which are interestingly located within the Gulf Arab countries, are presented as illustrations of initiatives that are supported by state and civic groups. They claim the potential to enhance S&T policies in the Arab region. However, their contribution might be effective only over the long run, and may be constrained by lack of awareness and the absence of regular funding schemes due to their overwhelming dependence on charity and individual supporters (political or business leaders). Thus, the challenge remains to rethink the linkages between higher education and science policies as part of he broader restructuring of the state and the enhancement of political participation and regional cooperation. Without the rethinking of the Arab state, and the ensuring of political participation, these linkages will remain weak, reproducing the frailty of regional and nation development plans over time.

The Arab countries need to benefit from the useful lessons and experiences of emerging Asian countries to promote education and S&T policies. For instance, the findings of Amsden and Lall as we explained in Section 1 above, indicate that the experiences of emerging Asian countries involved intense learning and acquisition of knowledge as a crucial determinant of economic growth; innovative control mechanisms imposing discipline on economic behaviour; globalization and institution building. It also implies an extensive role for the government to guide economic development, promote a broad educational base and human capital (mainly, by development of tertiary enrolment especially in technical subjects and trained technical personnel); science and technology policies and technological capabilities as a top policy priorities for these countries.

Table 1: Select Characteristics of Gulf and Mediterranean Arab Countries (2007)

Country	HDI (%) (2007)	Adult Literacy Rate (%) (1997-2007)	Combined enrolment ratio (%) (2007)	Total Population (Million) (2007)	GDP/per capita (PPP US $) (2007)
Gulf Arab Countries					
High income					
Qatar	0.910	93.1	80.4	1.1	74,882
United Arab Emirates	0.903	90	71.4	4.4	54,626
Kuwait	0.916	94.5	72.6	2.9	47,812
Bahrain	0.895	88.8	90.4	0.8	29,723
Saudi Arabia	0.843	85	78.5	24.7	22,935
Oman	0.846	84.4	68.2	2.7	22,816
All Gulf Arab countries	0.886	89.3	76.92	36.6	42,132
Mediterranean Arab Countries					
Upper Middle income					
Lebanon	0.803	89.6	78	4.2	10,109
Algeria	0.754	75.4	73.6	33.9	7,740
Lower Middle income					
Tunisia	0.769	77.7	76.2	10.1	7,520
Egypt	0.703	66.4	76.4	80.1	5,349
Syria	0.742	83.1	65.7	20.5	4,511
Morocco	0.654	55.6	61	31.2	4,108
All Mediterranean Arab countries	0.738	74.63	71.82	180	6,556
All Arab countries	0.719	71.2	66.2	334.3	8,202

Source: UNDP-Human Development Report (2009) "Overcoming barriers: Human mobility and development" HDR 2009 Statistical Table, (2009), New York, NY: UNDP.

Table 2: Intra-regional and International Mobility of Students from Arab Countries, India, Singapore, and Korea (1999-2004)

Total (all countries)	Intra Regional Mobility (within the Arab region)				International (or internationally mobile) students. Total: Students from a given country studying abroad)					
	Gulf/ total (%)	Med/ total (%)	Other/ total (%)	All Arab/ total (%)	USA/ Total (%)	UK/ Total (%)	France/ Total (%)	Germany/ Total (%)	Australia/ Total (%)	Studying in USA, UK, France, Germany and Australia / Total Students from a given country studying abroad
Gulf Arab Countries										
Bahrain	0.08	0.003	0.042	0.125	0.226	0.33	0.008	0.003	0.033	0.6
Kuwait	0.03	0.004	0.098	0.132	0.414	0.117	0.011	0.002	0.013	0.557
Oman	0.029	0.002	0.087	0.118	0.069	0.201	0.001	0.001	0.022	0.294
Qatar	0.051	0.003	0.121	0.175	0.34	0.314	0.014	0.008	0.018	0.694
Saudi Arabia	0.022	0.002	0.074	0.099	0.402	0.175	0.009	0.003	0.011	0.6
United Arab Emirates	0.014	0.005	0.007	0.027	0.363	0.254	0.008	0.007	0.088	0.72
Total Gulf	0.029	0.003	0.07	0.102	0.305	0.198	0.007	0.003	0.028	0.541
Mediterranean Arab										
Algeria	0.003	0.009	0.001	0.013	0.008	0.017	0.837	0.018	0	0.88
Egypt	0.029	0.002	0.013	0.045	0.25	0.128	0.109	0.18	0.011	0.678
Lebanon	0.006	0.003	0.011	0.019	0.179	0.042	0.362	0.362	0.016	0.961
Libyan Arab Jamahiriya	0.006	0.026	0.012	0.044	0.025	0.246	0.554	0.077	0.009	0.911
Morocco	0.001	0.001	0.008	0.01	0.04	0.004	0.723	0.181	0	0.948
Palestinian Autonomous Territories	0.143	0.024	…	0.167	0.054	…	0.026	…	0.014	0.094
Syrian Arab Republic	0.039	0.004	0.122	0.166	0.061	0.032	0.191	0.116	0.002	0.402
Tunisia	0.001	0.019	0.001	0.021	0.026	0.004	0.655	0.12	0	0.805
Total – Mediterranean Arab	0.012	0.007	0.016	0.035	0.061	0.026	0.587	0.145	0.003	0.822
Other Arab countries										
Mauritania	0.032	0.315	0.023	0.37	0.041	0.012	0.556	0.083	0.013	0.705
Djibouti	0.013	0.034	0	0.048	0.003	0.003	0.813	0.001	0	0.82
Iraq	0.041	0.015	0.17	0.226	0.066	0.065	0.12	0.269	0.035	0.555
Jordan	0.049	0.004	…	0.053	0.245	0.125	0.028	0.152	0.022	0.572
Sudan	0.05	0.006	0.025	0.081	0.09	0.103	0.019	0.192	0.014	0.418
Yemen	0.489	0.015	0.302	0.807	0.11	0.064	0.017	0.06	0.001	0.252
Total Other Arab	0.113	0.036	0.068	0.216	0.143	0.087	0.144	0.114	0.015	0.503
Total – All Arab Countries	0.027	0.009	0.033	0.07	0.119	0.068	0.42	0.116	0.01	0.733
Non-Arab Countries										
Korea	…	….	…	…	0.953	…	….	…	…	…
Singapore	…	….	…	…	0.059	0.084	0.001	0.002	0.211	0.357
India	…	….	…	…	0.15	0.017	0.003	0.038	0.161	0.369

Source: Adapted from the UIS-UNESCO Global Education Digest (2006) statistics on International (internationally mobile) students: UIS- UNESCO web site (see note 50).

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